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APPRAISAL OF AIR POLLUTION IN SOUTH DAKOTA

E. Carl Charles, et al

South Dakota State Department of Public Welfare
Pierre, South Dakota

August 1962

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appraisal of Air Pollution in SOUTH DAKOTA

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"Meet the malady on its way" - Persius (A. D. 58)

"The wisdom of prevention is better than the wisdom of remedy."
Unknown (A. D. 1685)

APPRAISAL OF AIR POLLUTION IN SOUTH DAKOTA

A cooperative survey by the
South Dakota State Department of Health
and the
Public Health Service
October 1961 - May 1962

Details of illustrations in
this document may be better
studied on microfiche.

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APPRAISAL OF AIR POLLUTION IN SOUTH DAKOTA

SUMMARY AND CONCLUSIONS

Air pollution can be defined as the presence in the ambient atmosphere of substances in concentrations sufficient to be injurious to human, plant or animal life or property or to unreasonably interfere with the comfortable enjoyment of life and property.

A growing concern over the increasing number of public complaints about air pollution led the South Dakota Legislative Research Council to request that the State Department of Health conduct a state-wide air pollution survey. The objects of this survey were threefold: to determine the extent of air pollution in South Dakota; to evaluate presently available means for coping with the problem; and if necessary to recommend any steps required to restore and preserve the State's air resources. The State Department of Health requested the assistance of the United States Public Health Service in conducting this survey. Arrangements for the survey were completed in September 1961 and the survey itself, consisting of questionnaires, field inspections, and a review of existing information commenced in October 1961. This report is the result of the joint effort of these two agencies.

A survey of public officials determined that South Dakotans are experiencing the effects of air pollution ranging from reduced visibility to alleged health disturbances and including numerous nuisances and damage to vegetation and property.

Information gathered from published data and field trips indicates that air pollution emanates from domestic sources, (space heaters and backyard trash burners); municipal sources, (burning dumps and septic sewage); transportation sources, (mostly motor vehicles); and industrial sources, (agriculture, manufacturing, and electric power generation.)

Meteorological conditions in South Dakota are generally conducive to air pollution dispersion because of favorable winds. However, all areas of the State experience short periods of poor atmospheric dispersion.

State population projections call for a slight increase in total population and a substantial increase in the urban segment in the near future. Similar economic projections indicate that there will be increasing industrial activity in the Black Hills and in the southeastern corner of the State. Both trends point to additional air pollution problems in the future.

At present, air pollution control capabilities in South Dakota are inadequate. Existing statutes do not assign responsibility for air pollution control to any agency and do not specifically authorize the control of air pollution except as a nuisance or threat to the public health. The results are ineffective leadership on a State level in the air pollution field; non-existent air pollution control programs on a local level; and an inability to establish a positive, preventive approach to the control of air pollution on either level.

South Dakota needs effective air pollution control legislation now and is in an ideal position to initiate legislative measures to prevent the air pollution problems which will inevitably appear. This preventive approach will undoubtedly be preferable to initiating abatement procedures after additonal problems are created.

It is advantageous to vest authority for prevention and control of air pollution in local governmental agencies. In this way, air pollution program activities are most responsive to local interests and certain economies can be affected in operation of control programs. However, since most units of local government in the State lack the financial ability to maintain the staff and facilities needed in certain air pollution program work, it is essential that the State provide substantial leadership and assistance to local governments. It is also necessary that the State provide adequate authority to local governments which would enable them to undertake air pollution control programs.

Illustration 1
Burning dumps are a frequent source of air pollution.

Illustration 2
An example of an improperly designed and poorly constructed wood waste incinerator which emits large quantities of smoke and cinders to the atmosphere.

RECOMMENDATIONS

STATE GOVERNMENT

Legislation

The establishment of a sound basis for control of existing and potential air pollution problems in South Dakota hinges on adequate legislation. Adequate legislation should include the following elements:

1. A preamble expressing the intent of the legislation. This intent should include statements that (a) all manifestations of air pollution (reduced visibility, vegetation damage, property damage, nuisances, possible injury to health, etc.) are within the scope of the legislation, (b) the primary responsibility for prevention and control of air pollution shall rest with local government (counties, townships, and municipalities).
2. Authorization enabling counties, townships, and municipalities to adopt ordinances regulating air pollution emissions and to require that suitable provisions be made in proposed establishments to control air pollution emissions.
3. The State should be authorized to provide substantial assistance to local governments in establishing and operating air pollution control programs.

4. Authorization enabling the State Department of Health to promulgate rules and regulations necessary for the prevention and control of air pollution where damage to public health is involved.

5. A statement encouraging public agencies to exhibit leadership in the field of air pollution by controlling emissions from publicly owned facilties.

Program Activities

The success of the State's program will depend on availability of funds to support necessary activities. Initially the State's program should consist of:

1. Assistance to counties, townships and municipalities in the development of ordinances and programs for the control of air pollution.

2. Technical assistance from the State to counties, townships, and municipalities on air pollution problems requiring more resources than those available to the local government and especially concerning interjurisdictional air pollution problems.

3. Appropriate abatement action in air pollution situations where damage to public health may be involved.

4. Encouragement of municipalities and counties to give consideration to air pollution matters in planning and zoning activities.

5. Education directed toward the public and those persons directly responsible for air pollution through the dissemination of information on air pollution prevention and control.

Ultimately program efforts should also include:

1. Appropriate research projects
2. Appropriate air pollution surveys
3. A state-wide monitoring program of modest proportions
4. A laboratory staffed and equipped to supply the services required by the State's air pollution program.

LOCAL GOVERNMENT

Counties, townships, and municipalities should:

1. Establish and operate air pollution programs where appropriate, particularly in the more populous areas of the State. These programs should provide for the control of air pollution from existing sources and insure that future establishments will comply with emission criteria.

2. Initiate and strengthen planning and zoning programs which should include consideration of air pollution.
3. Attempt to furnish complete refuse collection and proper refuse disposal in an effort to eliminate back yard burners and burning dumps.
4. Provide or enlarge sewage treatment facilities where necessary to eliminate odors emanating from inadequate facilities.
5. Keep the public informed of local air pollution control activities.

INDUSTRY

Industry should:

1. Seek solutions to the problems of air polluting emissions and apply such solutions to existing sources of excessive pollution.
2. Consider air pollution factors in locating new industry and expanding old.
3. Utilize the best air pollution control knowledge in the design and operation of industrial plants.
4. Support research and investigations directed toward the solution of air pollution problems.
5. Assist in the evaluation and control of air pollution.

UNIVERSITIES

Universities and other research organizations should:

1. Provide training for industry, government and other groups interested in the control of air pollution.
2. Intensify research activities in the air pollution study and control fields.

PUBLIC

The public should:

1. Control excessive or unnecessary air pollution originating on private residential premises.
2. Accept and support changes in community facilities and community organization which will control air pollution.

INTRODUCTION

The citizens of South Dakota have been fortunate in past years with their heritage of an abundant supply of air relatively free of injurious contaminating substances; however, there is increasing evidence that the supply of clean air in South Dakota is not universally unlimited. Development of air pollution situations is evidenced by public complaints registered with various representatives of government throughout the State.

Realization that polluted air threatens damage to health, agricultural products, and real estate values has resulted in efforts to develop control legislation. One such effort was the introduction of an air pollution control law (Appendix A) during the 1957 session of the South Dakota State Legislature. This bill was not enacted.

The lack of governmental capabilities to deal with the increasing number of air pollution complaints was called to the attention of the South Dakota Legislative Research Council following this initial failure to establish air pollution control legislation. This resulted in a request from the Legislative Research Council to the State Department of Health to undertake a state-wide survey of air pollution designed to define present and future control needs. The State Department of Health requested the U. S. Public Health Service to provide assistance in conducting this survey as authorized by Public Law 159, 84th Congress, as amended. Arrangements for this cooperative survey were completed in September, 1961.

The major survey effort was initiated in October 1961. The survey consisted of the collection and compilation of information relating to sources of air pollution, the harmful effects of these pollutants, present legislation, and governmental air pollution control activities. Existing reports were utilized for data such as population, fuel usage, climatology and refuse disposal. Future air pollution was estimated from information on trends associated with the emergence of air pollution problems in other areas.

Local air pollution problems were reviewed through a questionnaire survey, field interviews, and a study of past complaints. The Air Pollution Appraisal Questionnaire (Appendix B) sent to municipal and county officials and the County Agents Agricultural Questionnaire (Appendix C) are attached. The South Dakota Cooperative Extension Service assisted in the distribution and collection of the agricultural questionnaires.

After review of the questionnaires, field interviews were conducted with those officials reporting air pollution problems within

their jurisdiction. Several of the reported air pollution problems were investigated to obtain more information and, in some instances, photographs of pollution sources.

The data collected were used to define the status of air pollution. Evaluation of this situation in light of present air pollution control capabilities established the primary basis for the recommendations made to control existing problems and conserve the air resources over South Dakota.

EFFECTS OF AIR POLLUTION

GENERAL

Human Health

Evidence indicates that acute exposures to grossly polluted atmospheres can result in illness and death. Six major air pollution episodes have been reported since 1930. In each episode a large percentage of the exposed population (43% in one case) became ill from inhaling toxic materials.[1] Symptoms of illness ranged from a cough to nausea and vomiting; most severe symptoms occurred in persons having a history of respiratory disease.

During these episodes, which lasted from 4 days to a week, mortality rates were higher than normal with the majority of excess deaths occurring in the age group over 45 years old. The cause was generally agreed to be a combination of two or more chemical irritants present in the atmosphere in unusually large concentrations as a result of stagnating weather conditions. Although the number of these incidents is small, they illustrate that air pollution can cause considerable health damage, including severe illness and death.

A lifetime of exposure to low-level concentrations of air contaminants poses a health effect much more difficult to evaluate. Findings in numerous studies have linked long-term, low-level exposure with cancer of the lung, stomach, and esophagus; some chronic lung disorders including chronic bronchitis and emphysema; and certain cardio-respiratory diseases.[2] Circumstantial evidence to date cannot prove a cause and effect relationship between air pollution and non-acute effects on health, but it does strongly suggest that there is a relationship between these disorders and polluted atmospheres.

Air transports microscopic plants, yeasts, molds, danders, hair, fur, feathers, and pollens, which cause allergic reactions

in some people. These may appear as skin eruption or as an impediment to respiration. Control of these natural pollutants is difficult because of their many unknown characteristics and the widespread distribution of the sources of some of the materials.

Summarizing, air pollution has caused acute health damage and probably is one factor responsible for a number of chronic lung and heart diseases.

Economic

Animal: The most costly livestock injuries resulting from air pollution are those attributable to air-borne fluorides. Here the problem is one of ingestion rather than inhalation. Fluorides emanate from a number of industrial processes and accumulate on and within vegetation used as forage. Regular ingestion of grass or forage containing excessive fluoride for a long period can lead to fluorosis in an animal. This disease is characterized by mottled teeth, deformed bones, weight loss, reduced fertility and in the case of dairy herds, reduced milk production. [1]

Livestock losses have also been attributed to systemic poisonings by ingestion of air-borne arsenic and lead. [3] These compounds may be present in industrial effluents and in insecticide sprays. Poisoning may result from the ingestion of forage containing large amounts of toxic material for a short period of time, or the ingestion of forage containing small amounts for a longer time. Animal injury is possible in South Dakota and depends on the influx of industries with toxic, air-borne wastes.

Animal investigations following the previously mentioned episodes were not as intensive as human investigations but the reports suggest that animal responses were similar to those experienced by humans. The severity of symptoms and the number of deaths varied with the species of the animal. Under present conditions the possibility of an episode in South Dakota is remote.

Vegetation: Air pollution in this country is responsible for millions of dollars worth of damage to vegetation annually. Damage may result from drifting sprays, from interference with photosynthesis and respiration due to dust accumulations on plant leaves, and by the direct action of chemical phytotoxicants. Sulfur dioxide, fluorides, and photochemical smog are among the most devastating of the phytotoxicants and account for most plant damage attributable to air pollution.

The effects of sulfur dioxide on vegetation have received considerably more attention than the effects of other phytotoxicants and exhaustive studies have been made in the past following widespread damage to vegetation in the vicinity of large smelters. Alfalfa, barley, endive, and cotton are very sensitive to sulfur di-

oxide exposures; less sensitive plants include rhubarb, radishes, lettuce, sweet potatoes, pumpkin, oats, clover, carrots, turnips, and wheat.[1]

Sulfur dioxide injury to plants is local rather than systemic. In sufficient concentrations, this gas causes the plant cells in all or part of the leaf to collapse. The extent of the injury and the loss of produce are approximately proportional to the leaf area destroyed.

Fluoride compounds discharged from certain industrial processes such as aluminum reduction, smelting of certain iron and non-ferrous ores, ceramic production, phosphate reduction, and phosphate fertilizer production, are toxic to a few plants in very low concentrations but do not affect other plants at concentrations 100-fold higher. Plants sensitive to fluoride injury include gladiola, azalea, milo maze, some varieties of corn, strawberries, peaches, grapes, sweet potatoes, iris, and Ponderosa pine.[1]

There is an important difference between the effects of fluoride and sulfur dioxide on plants. Fluorides concentrate in the perifery of the affected leaf and may adversely affect photosynthesis and repiration without visible leaf destruction; however, visible injury appears when critical fluoride levels are attained.

There is no photochemical smog in South Dakota. There are other air-borne phytotoxicants including ozone, acid aerosols, ethylene, and nitrogen oxides, which are of lesser importance. Chlorine, hydrogen chloride, ammonia and hydrogen sulfide, which may be toxic to plants, are not usually found in the community atmosphere in sufficient concentrations to cause plant damage.

Summarizing, air-borne pollutants cause considerable economic losses because of widespread plant damage. To date the principal offenders reported have been sulfur dioxide, fluorides, and photochemical smog.

Other: Air pollution causes other economic loses, which because of their insidious nature are difficult to recognize. Reduced visibility can be a real cause of economic loss by creating hazardous flying and driving conditions that result in accidents costly in lives and dollars.

It hampers the flow of traffic in the air and on the highways, delaying passengers of airplanes and motor vehicles; expensive new and expanded facilities are required to handle the increased traffic.

Soiled buildings and clothing require sizeable expenditures for maintenance and laundering. Large particles settling on porches, window sills, sidewalks and automobiles require expensive cleaning often abrasive in action; fine particles permeate homes,

soiling rugs, curtains, and clothes.

Corrosion of building materials such as stone, masonry and metal is costly. Some metals and masonry materials are very susceptible to decomposition from chemicals present in the urban atmosphere, and require costly protective coatings.

Leather, rubber, and textiles crack and deteriorate at an increased rate in polluted atmospheres. Air pollution increases the frequency and duration of fog because of the availability of small particles that form the nuclei for water droplets. Aerosols plague the electrical industry with minute particles that can damage delicate components, and the paper industry by spotting paper with air-borne dirt. Dismal atmospheres associated with air pollution foster human inefficiency and absenteeism. The many manifestations of air pollution create undesirable neighborhoods which reduce property value.

These are the subtle effects of air pollution. Although often hidden, these effects are costly. There is an appropriate saying in air pollution literature that tells the story: "Clean air costs money; polluted air costs more."

SOUTH DAKOTA

Citizens in South Dakota experience adverse effects of air pollution daily, ranging from reduced visibility to alleged health disturbances. Table 1 summarizes the information obtained from questionnaires sent to all areas of the State. These data demonstrate that many public officials in South Dakota are aware of air pollution.

Reduced visibility resulting from heavy atmospheric loadings of dust or smoke was observed in several areas during this survey. (Illustration 3).

The urban population suffers economic losses from the replacement of building materials damaged by atmospheric corrosion; added maintenance and redecoration of buildings and reduced real estate values; the housewife spends more of her money on cleaning and frequently has her laundry, drying on a clothesline, blackened by smoke from a neighbor's trash burner.

Two of the five public officials who cited vegetation damage (Table 1) were interviewed during the survey. One stated that the effluent from an ammonium phosphate fertilizer plant was alleged to have killed a number of nearby trees. In the other instance, dust from a rock crushing operation and a cement plant was named as the cause of vegetation damage. Although further study is necessary to substantiate these claims, the number of questionnaires noting vegetation damage indicates public awareness of this problem.

Illustration 3

A high atmospheric dust loading results in reduced visibility. This photograph was taken at approximately 11:00 a.m. on a bright, sunny, dry day in the area encompassed by the pollution shown in illustration 12.

A number of cities were plagued with objectionable odors from septic sewage, industrial plants, and burning garbage, which not only annoy the citizens but depress property value.

Table 1. RESULTS OF 1961 QUESTIONNAIRE SURVEY ON EFFECTS OF AIR POLLUTION IN SOUTH DAKOTA

Air pollution problem	Questionnaires reporting problem[a]	
	Number	Per Cent
Discomfort or inconvenience to residents	34	18.3
Damage to property	7	3.8
Damage to vegetation	5	2.7
Injury to animal life	3	1.6
No problem	152	82.0

[a]Of 300 questionnaires (Appendix B) sent, 186 were returned and some questionnaires reported more than one problem.

Two incidents indicated health effects from air pollution. One individual was reported to have an allergenic response to the emissions of a local manufacturing operation; another, already the victim of a respiratory disease, stated that his physical condition

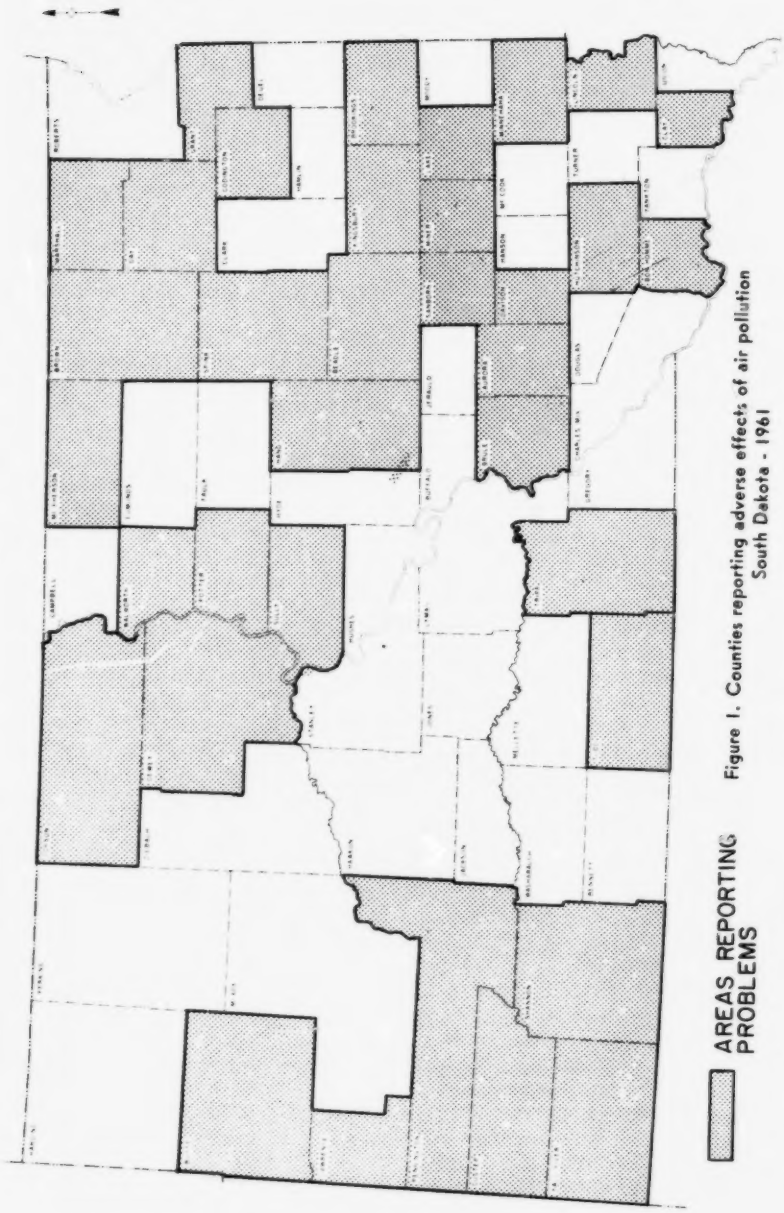

Figure 1. Counties reporting adverse effects of air pollution
South Dakota - 1961

was aggravated by smoke that periodically engulfed his town from several nearby wood waste incinerators. Again further study is needed to substantiate these allegations.

Figure 1 illustrates the distribution of South Dakota's air pollution problems, as determined from returned questionnaires (Appendices B and C). Air pollution affects at least 35 of the 67 counties in the State; 25 of these affected counties are east of the Missouri River.

Illustration 4
The pall of pollution blanketing this South Dakota community was brought about by the accumulation of atmospheric pollution rising from numerous smaller sources.

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TRENDS AFFECTING SOUTH DAKOTA'S AIR RESOURCES

POPULATION

Air pollution is a direct result of man's many activities, space heating, waste disposal, manufacturing, electric power generation, and other operations. It follows that a knowledge of South Dakota's population distribution and its trends are essential to any appraisal of the air pollution problem in this State.

One of the indicators of an existing air pollution problem is population density, since more people living in a square-mile area usually means more atmospheric pollutants will be emitted to the air over that square mile. Figure 2 shows the population densities for the counties in South Dakota.

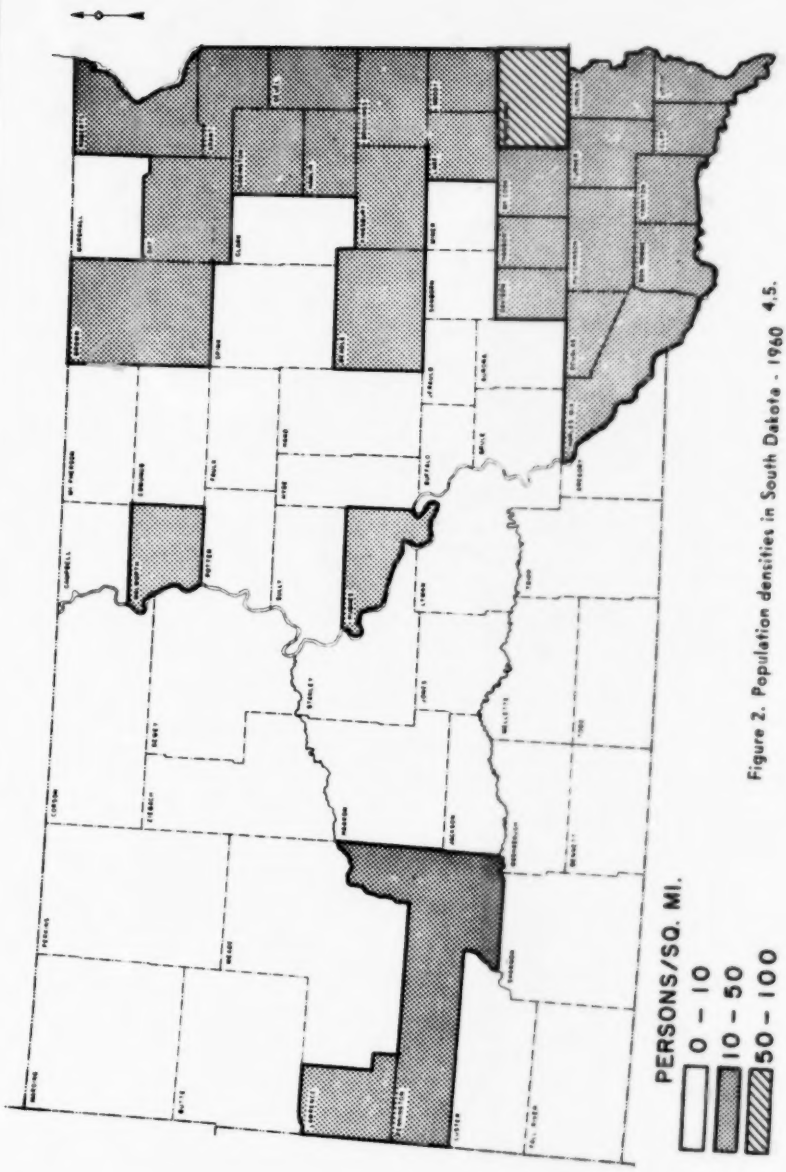

Figure 2. Population densities in South Dakota - 1960 4.5.

Similarly, South Dakota's population trend is a most useful tool in estimating future problems. The State's population totaled 680,514 as of April 1, 1960. This is an increase of 27,774 persons or 4.3 per cent over the 1950 census.[4] Even with this increase, the State's total population is 1.8 per cent below the peak year of 1930.[6] Depression years accompanied by a severe drought resulted in an emigration following the 1930 census which accounts for that loss in population. Among the states, South Dakota ranks 41st in total population and 43rd in per cent increase over the 1950 census.[7]

Although the state-wide population increase of 4.3 per cent lags behind the national average of 18.5 per cent, certain areas of the State have had significant population increases.[7] Stanley, Pennington, Hughes, and Minnehaha Counties, comprising 23.7 per cent of the State's population in 1960, showed increases of 98.8, 70.9, 56.9, and 22.1 per cent respectively from 1950 to 1960.[4] Figure 3 shows the counties increasing and decreasing in total population for the same period.

Sioux Falls is the largest municipality in the State and had a population of 65,466 on April 1, 1960, an increase of 22.1 per cent over the 1950 census.[4] South Dakota has eight cities with populations over 10,000 (Aberdeen, Brookings, Huron, Mitchell, Pierre, Rapid City, Sioux Falls and Watertown) which comprise 28.1 per cent of the State's population.[4]

The rapid expansion of many urban areas in the State and the general decline in rural population demonstrates the tendency of the population to concentrate. Although South Dakota's urban population was only 39.2 per cent of the total State population in 1960 compared with the national figure of 70 per cent, the State's urban population has increased steadily (Figure 4). From 1870 to 1960 the population transformed from all rural to 39.2 per cent urban. In just ten years (1950-1960) this urban population had increased 23.3 per cent.[4] The eight large cities mentioned earlier had an average increase of 30 per cent over the last 10 years compared with only 4.3 per cent for the entire State in the same period.[4]

The Business Research Bureau of the State University of South Dakota predicts that by 1970 the State population will total 717,760, a 5.5 per cent increase over the 1960 census.[8] While this increase appears small if analyzed by regions (Figure 5) the predictions are more meaningful. The population predictions include increases of 20.8 per cent in the Black Hills Region, 6.5 per cent in the Southeastern Region, and 2.0 per cent in the West North Central Region. Two regions, the Central Region and the North Central Region, are expected to decrease in population 3.2 per cent and 0.1 per cent respectively. These estimates are based in part upon reduced but continuing emigration from some rural areas and continuing

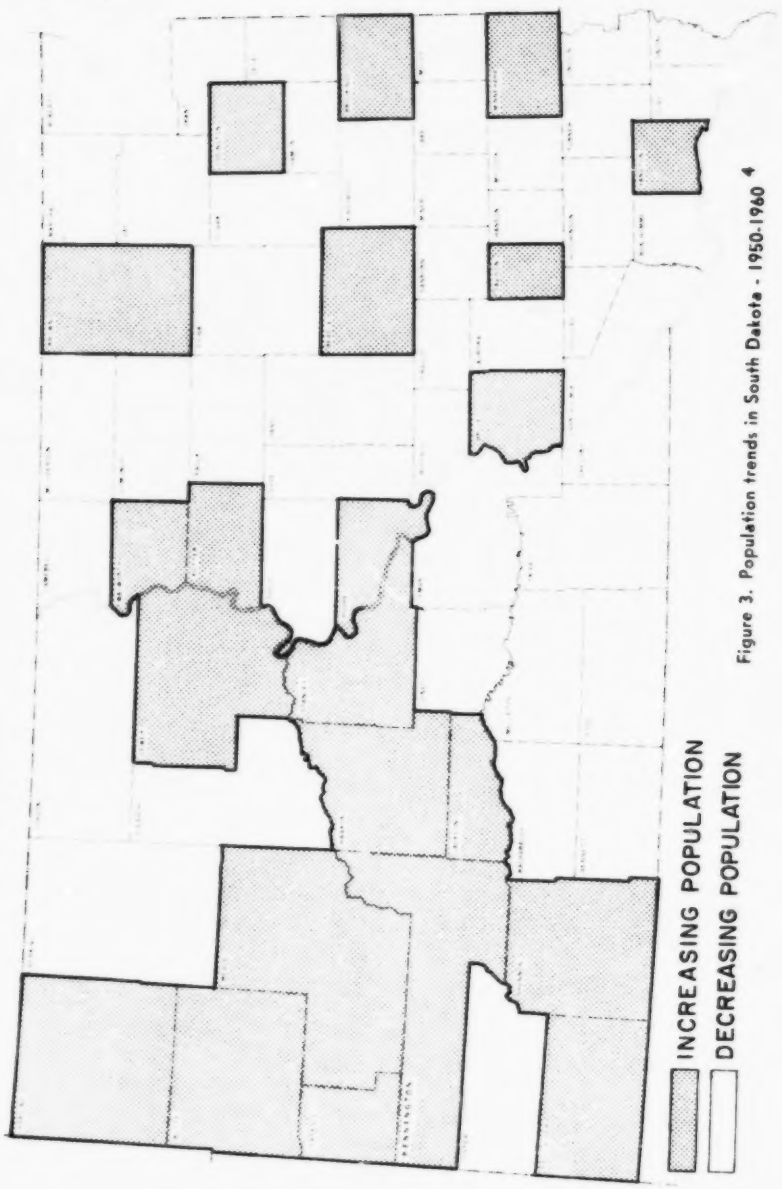

Figure 3. Population trends in South Dakota - 1950-1960

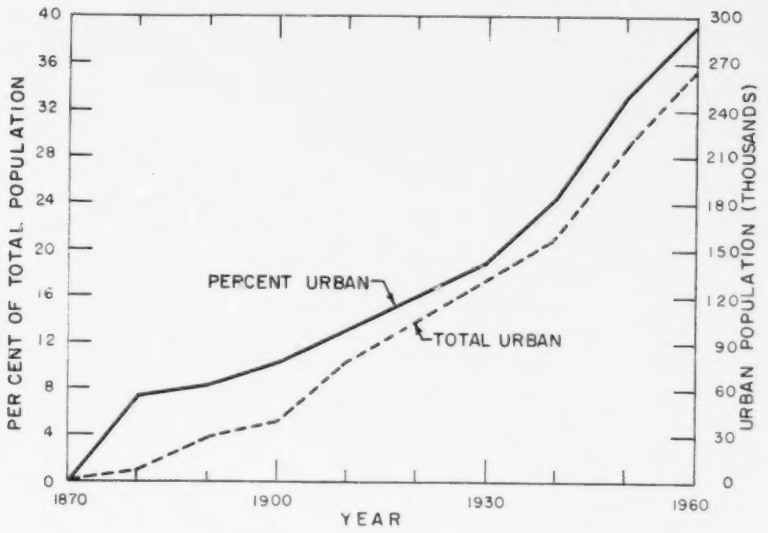

Figure 4. South Dakota's urban population - 1870-1960 [6]

immigration to urban centers. Pollution emissions from the activities of these additional people will place an added burden on the air supplies of many urban areas.

ECONOMY

An integral part of this air pollution report is a look into the future. Like population trends, the trend of South Dakota's economy has a direct bearing on the future of the State's air resources. If the State's economy is to expand even moderately, the expansion probably will involve an influx of industry. Certain of these industries will have operations that may, if uncontrolled, discharge significant quantities of undesirable wastes into the atmosphere. Therefore, a discussion of the State's economy and its prospects for the future is necessary when considering plans for conserving the State's air resources.

The Business Research Bureau at the University of South Dakota has divided the State into five regions. (Figure 5) The present and future economies of these regions are described in five volumes. [9, 10, 11, 12, 13] The following paragraphs contain a synopsis of these five volumes.

Of the five economic regions of South Dakota the North Central Region is presently the most dependent on agricultural production for its income, and this income is almost entirely from wheat. [9] The future economy of this Region will certainly be re-

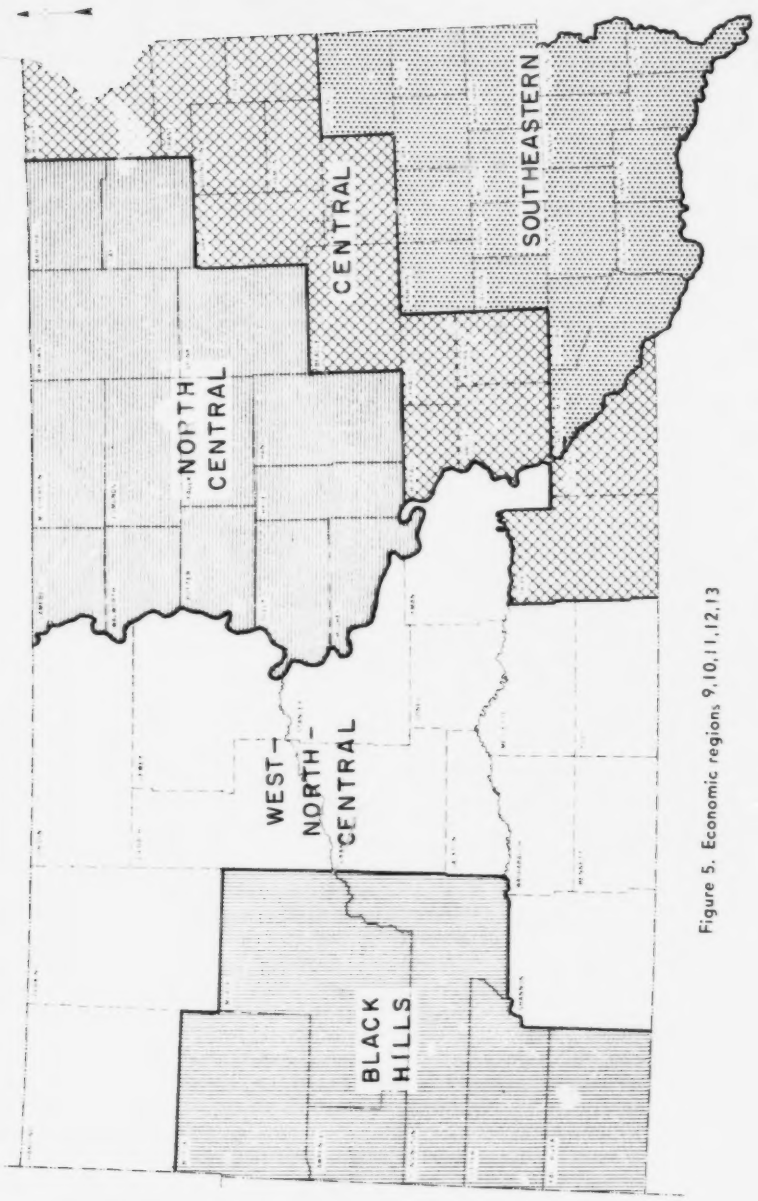

Figure 5. Economic regions 9,10,11,12,13

lated to agriculture but its pattern may change somewhat if irrigation water from Oahe Lake, the James River, or irrigation wells is made available. This water could afford protection against a crippling drought and in addition a reliable source of water would enable area farmers to diversify their crops.

The economy in the West North Central Region, which presently derives 50 per cent of its income from agriculture, may change in the near future.[10] Considerable attention has been given recently to the possibility of exploiting the available natural resources. Lignite, which is valuable as a fuel and as a source of uranium, is second only to water as an important natural resource in this Region.[10]

Petroleum and natural gas are two natural resources of this Region that have received considerable attention recently. The northwestern corner of this Region lies in a geophysical area known as the Williston Basin, which also includes part or all of North Dakota, Montana, and several Canadian provinces. The Williston Basin possesses geophysical conditions conducive to the accumulation of petroleum and natural gas and may become one of the largest oil-producing areas in North America. Other natural resources available for exploitation in the West North Central Region are bentonite and manganese.

The Central Region of the State presently receives about one-third of its income from a diversified agricultural economy; the most important agricultural products are livestock, corn, and hay.[11] This Region also contains 20 per cent of the State's manufacturing establishments. Between 1939 and 1954 production of goods through manufacturing increased 413 per cent, indicating that manufacturing in the future may fill a larger segment of the Central Region's economy.

The Southeastern and the Black Hills Regions of the State are the only Regions whose economies are somewhat diversified. The Black Hills Region obtains the majority of its income from the timber, mineral, and tourist industries.[12] Income from agriculture in the area totals approximately 10 million dollars annually, with three-fourths of this sum derived from cattle and sheep. The timber industry produces 45 million board feet annually from existing mills whose combined capacity is rated at 73 million board feet annually. An increasing use of lumber in the expanding national economy combined with increasing demands for pulp and paper appear to insure the future of the timber industry in the Black Hills. The mineral industry, which in the future will probably overshadow all the other industries mentioned, now yields 39 million dollars of annual income to the area. Minerals being mined are bentonite, beryl, copper, lead, zinc, iron felspar, gold, silver, gypsum, mica, and quartzite. Tourism, the State's second

largest industry, grosses over 100 million dollars annually.[14] Three-fourths of this sum is spent by tourists in the Black Hills. Tourism undoubtedly will become increasingly important to South Dakota, fostered by the State's prodigious supply of game, the Black Hills' famous Mt. Rushmore Memorial, the reservoirs along the Missouri River, and other attractions.

Although the Southeastern Region of the State has a considerable agricultural income, its economy is diversified.[13] In addition to farming, this area contains about 40 per cent of the State's manufacturing firms which employ 60 per cent of the State's industrial workers. With Sioux Falls, the largest wholesale center in South Dakota, this Region accounts for over 80 per cent of all wholesale sales in the State. The Region's growth as a manufacturing center will probably continue. Development of recreational facilities at the Gavins Point and Fort Randall dams is a possible source of income for the future.

The foregoing synopsis indicates that South Dakota's main industry is agriculture. It also reveals that a number of other industries are active in South Dakota. From this economic discussion of the State and the population estimates discussed earlier, it would appear that industry and population in three regions, the North Central, the West North Central, and the Central, will remain constant or decrease slightly. As a result, the air over these Regions probably will not undergo any significant deterioration in the immediate future; however, these Regions undoubtedly will be confronted with some air pollution problems.

The same population and economic discussions indicate that the Black Hills and Southeastern Regions, especially the former, will encounter an increasing number of air pollution problems with a continuing deterioration of the air resources over these Regions unless air pollution control programs are instituted.

The initiation of a preventive air pollution program now, emphasizing planning and education, can result in the prevention of complex problems that will undoubtedly result if the situation is left unattended.

SOURCES OF AIR POLLUTION

DOMESTIC, MUNICIPAL, AND TRANSPORTATION SOURCES

As referred to in this report, domestic sources of air pollution are space heaters and backyard refuse burners; municipal sources include those operations associated with refuse disposal and sewage treatment. Transportation sources include all motor vehicles, water-borne vessels, trains and airplanes, however, in

this report discussion of transportation sources will be limited to the motor vehicle since it is responsible for the largest portion of emissions attributed to transportation vehicles in South Dakota. Other transportation sources are insignificant.

Space heating, backyard refuse burning, and motor vehicles all involve the process of combustion with concomitant emissions to the atmosphere. Sewage treatment and municipal refuse disposal may or may not involve a combustion process.

The internal combustion of gasoline in motor vehicles and the combustion of coal, oil, and gas in space heaters are relatively efficient. In backyard refuse burning the fuel may be a heterogeneous mass of wet garbage, paper, and grass trimmings and the combustion is inefficient. Although these sources appear individually to be insignificant, taken collectively their emissions can threaten the quality of a community's air resources.

Table 2 reveals that 38 public officials indicated municipal activities were a source of objectionable community air pollution. Fourteen questionnaires stated that domestic activities were a cause of air pollution problems.

Table 2. RESULTS OF 1961 QUESTIONNAIRE SURVEY ON SOURCES OF AIR POLLUTION IN SOUTH DAKOTA[a]

Source of air pollution problem	Questionnaires reporting indicated source[b]	
	Number	Percent
Municipal activities	38	20
Domestic activities	14	8
Commercial activities	11	6
Industrial activities	30	16
Agricultural activities	11	6
Natural	7	4
None	126	68

[a]Three hundred questionnaires (Appendix B) were sent; 186 were returned.
[b]Some questionnaires reported more than one source.

Space Heating

Space heating in densely populated areas can be an important source of air pollutants. The significance of space heating as a source of pollutants depends on several factors, such as the amount of heating required, the type of fuel supplying this heat, and the condition of the firing equipment.

The number of heating degree-days is an indication of the amount of space heating required. The value of any given day in terms of heating degree-days is the difference between the average temperature for that day and 65°F. No degree-day value is assigned, however, unless the average temperature falls below 65°F. Sioux Falls, Rapid City, and Huron annually averaged 7848, 7855, and 7902 degree-days respectively over the period 1921-1960.[15, 16, 17] When these figures are compared with those for a State like North Carolina, which has between 3000 and 4000 heating degree-days annually, the importance of space heating in South Dakota becomes more apparent.[18] A degree-day value is a numerical way of stating that South Dakota has severe winters and as a result large quantities of fuel are consumed for heating purposes. Because of the extremely cold winters, domestic space heating is more significant as a source of air pollutants in South Dakota than it is in areas with milder winters (Illustration 5).

Illustration 5

[illegible] photograph [illegible] appeared in the Decem[illegible] 1961 [illegible] Sioux Falls Argus-Leader [illegible] [illegible] [illegible]

Table 3. COMPARATIVE EMISSIONS FROM COAL, OIL, AND GAS FIRED IN DOMESTIC UNITS (VARIES WIDELY) [a]

Pollutant	Pounds of pollutants emitted per 10,000,000 heating units supplied[b]		
	Coal[c]	Oil[d]	Gas[e]
Sulfur dioxide	15.0	2.8	0.0
Nitrogen dioxide	0.2	0.7	1.9
Total hydrocarbons	8.3	2.6	0.7
Total particulates	10.0	0.1	trace
Aldehydes	not available	0.9	0.2

[a]References 19, 20, 21, 22, 23.
[b]Emissions based on 10,000,000 BTU produced by each fuel.
[c]850 pounds of coal with a 1% sulfur content and a 7% ash content.
[d]70 gallons of No. 2 fuel oil with a 0.3% sulfur content.
[e]10,000 cu. ft. of natural gas with a sulfur content of 0.4 gr./100 cu. ft.

gas is burned is insignificant when compared with total emissions from burning oil and coal. The emission comparisons made here are based only on domestic heating equipment which do not usually have air pollution control devices. Table 4 shows the distribution of space heating fuels used in South Dakota residences. The 1950 Census of Housing indicates that the use of coal, oil, and gas was almost equally divided, each heating approximately one third of the homes located in South Dakota's urban areas.[24]

Table 4. FUELS USED IN SOUTH DAKOTA FOR RESIDENTIAL HEATING - 1950[a]

Fuel	Per cent of dwelling units using indicated fuel	
	State-wide	Urban
Coal	36.9	33.9
Wood	5.8	1.8
Utility gas[b]	12.1	31.3
Bottled gas	5.3	2.0
Liquid fuel[c]	36.5	28.2
Other	3.4	2.8

[a]Reference 24.
[b]Includes natural and manufactured gases.
[c]Includes fuel oil, furnace oil, distillate oil, kerosene, coal oil, stove oil, range oil, lamp oil, gasoline, and alcohol.

Natural gas supplied 29 per cent of the State's total heat energy in 1957 (Table 5). Coal supplied 34 per cent and oil 30 per cent. As natural gas becomes available to other areas of the State (presently only the eastern and western ends of the State have access to natural gas) it probably will supply a larger percentage of the State's total heat energy. The increased use of natural gas for space heating in densely populated areas may bring about substantial reductions in the over-all air pollution load.

Table 5. TOTAL FUEL CONSUMPTION IN SOUTH DAKOTA - 1957[a]

Fuel	Amount consumed	Per cent of total heat units[c]
Coal	838,000 tons	34
Fuel oil	147,000,000 gallons	30
Liquified petroleum gas	57,544,000 gallons	7
Natural gas	19,582,000 MCF[b]	29
Total		100

[a]Reference 25, 26, 27, 28.
[b]MCF - One thousand cubic feet.
[c]Total heat potential equals 67.4×10^{12} BTU.

The emissions of some pollutants, such as carbon monoxide, smoke and hydrocarbons, are related to the efficiency of combustion, which in turn is dependent on the design and condition of the firing equipment. Some supervision of equipment design, installation, and maintenance, therefore, can be an effective method of reducing air pollution emissions.

Refuse Disposal

The solid wastes of a community, with the exception of excreta and dead animals, are usually referred to as refuse and include combustibles such as garbage, leaves, and paper, plus non-combustible ashes, ceramic materials, and dirt.[29] Effective collection and disposal of this refuse are necessary in any community that maintains a satisfactory level of sanitation.

In South Dakota, as in other areas of our country, refuse disposal operations are generally performed or supervised by the local governments. In South Dakota, with very few exceptions, individuals are permitted to dispose of some part of their refuse through back-yard burning. In most communities, because of insufficient refuse collection, the public depends on back-yard trash burners

to reduce the volume of domestic wastes and these burners emit air pollution. In other communities, the refuse is collected by the municipality but improper disposal creates an air pollution problem at the city dump, where fires are kindled intentionally to reduce bulk or start accidentally through spontaneous combustion.

Several methods are available to a community for the sanitary disposal of refuse, including sanitary landfill, municipal incineration, composting, and a combination of grinding and municipal incineration.[20] When properly used each of these methods will provide satisfactory refuse disposal.

Illustration 6

Sanitary landfill is the method best suited to most South Dakota communities and it is used by a number of cities throughout the State (Table 6). Composting, grinding, and municipal incineration are not economically feasible in South Dakota with the possible exception of the larger cities.

At this time, air pollution from improper refuse disposal poses the greatest threat to the State's air resources. Oxides of sulfur and nitrogen, hydrogen sulfide, ammonia, aldehydes, organic compounds and solids (smoke), originate from burning dumps and back-yard burners. Under adverse meteorological conditions these pollutants permeate South Dakota communities. The smoke causes reduced visibility and an annoying stench of partially burned garbage.

Table 6 demonstrates that 75 per cent of the communities with refuse collection disposed of their wastes on open dumps. Dumps observed during the survey were characterized by intermittent burning and continuous smoldering; in addition, at some refuse disposal operations designated as sanitary landfills, refuse was being burned instead of buried in the manner intrinsic to the sanitary landfill. Table 7 compares back-yard burning, burning dumps and sanitary landfill operations from the standpoint of air pollution emitted.

Indiscriminate back-yard burning is also a problem. In all but one of 25 communities visited wire baskets, oil drums, or refuse pits behind most of the houses are used for burning household trash. Individually these burners are a source of annoyance; the clouds of noxious smoke emitted soil laundry drying on the line and the repugnant odor of burning garbage drives neighbors from their yards. Collectively, the emissions from these burners place a considerable load on the communities' air resources (Table 7).

Illustration 7
One of numerous back-yard trash burners contributing its share of air pollution.

Table 7. EMISSIONS FROM REFUSE DISPOSAL BURNING VERSUS SANITARY LANDFILL FOR A CITY POPULATION OF 10,000[a]

Principal contaminants	Emissions in pounds per day		
	Back-yard burning	Burning dumps	Sanitary landfill
Sulfur oxides	18	18	0
Nitrogen oxides	9	9	0
Hydrogen sulfide	0	0	trace
Ammonia	35	35	0
Hydrogen chloride	0	0	0
Aldehydes	60	60	0
Organics	4200	4200	trace
Organic acids	23	23	0
Solids	340	700	low[b]
Total	4685	5045	low

[a]Reference 32.
[b]Low but variable.

Complete refuse collection with disposal at properly operated sanitary landfills and the elimination of burning dumps and back-yard burning would eliminate the air pollution associated with refuse disposal in South Dakota communities.

Sewage Treatment

Twenty-four of the 240 questionnaires (Appendices B and C) listed odors emanating from septic sewage as causing air pollution problems. Sources of these odors ranged from cesspools to municipal sewage treatment facilities, and included streams receiving untreated wastes from municipal collection systems and sewage stabilization ponds.

At present South Dakota has 155 municipalities, 17 Federal installations, and 10 State installations that provide sewage treatment for 50 per cent of the State's population; an additional 5 per cent are served by 22 sewage collection systems, the effluents from which are discharged into adjacent streams without treatment.[33]

The 182 sewage treatment facilities include 80 stabilization ponds. It was found during the survey that a few of these ponds were associated with odor complaints. This is of special significance since stabilization ponds have become a very popular method of sewage treatment in smaller communities in the last ten years because of their ability to provide good treatment with low construction cost and minimal annual maintenance.

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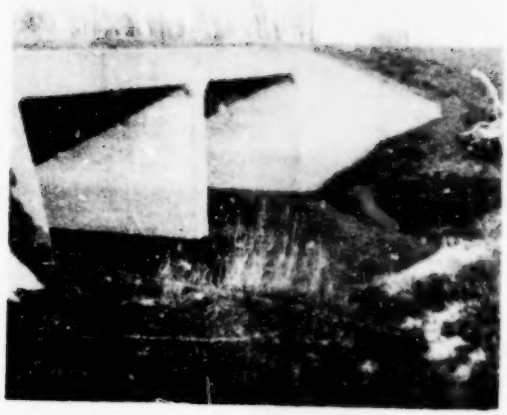

Illustration 8
A small stream receiving raw sewage. Odor from septic sewage is a source of annoyance.

Properly designed, operated and maintained stabilization ponds generally produce less odor than conventional sewage treatment plants. Odors are most likely to occur during the period of transition from ice to open water. Serious odor problems from stabilization ponds have been attributed to overloaded facilities, indiscriminate discharges of strong and abusive industrial wastes, a high concentration of sulfates in the water supply and poor maintenance.

The Federal Water Pollution Control Act (P. L. 660) passed in 1956 and amended in 1961 provides direct grants to communities for a portion of the cost of waste treatment facilities. As of April 1, 1962, eighty-two South Dakota projects have been allocated funds under this Act. A continued state water pollution control program, together with the grant provisions of P. L. 660, will result in construction of additional sewage treatment facilities with subsequent reduction of odors associated with improperly treated sewage.

Motor Vehicles

The motor vehicle has recently taken on an added significance as a source of air pollution since the discovery in Los Angeles that

vehicular exhaust was a major contributor to "smog" conditions. This "smog" is primarily the result of the interaction of hydrocarbons, oxides of nitrogen (both are components of motor vehicle exhaust), and ozone in the presence of intense sunlight. This photochemical "smog" has been associated with eye irritation, reduced visibility, and extensive damage to vegetation in the Los Angeles area and in other parts of the country.

Table 8 lists the amounts of pollutants emitted from automobiles for each 1000 gallons of gasoline burned. Figure 6 shows the motor vehicle registrations and gasoline consumption in South Dakota from 1920 through 1960. Both lagged during World War II after which they increased sharply and have steadily increased since 1950. At present South Dakota has one motor vehicle for every 1.9 persons for a total registration of 354,000 vehicles, which use approximately one million gallons of gasoline daily.

Table 8. AVERAGE AUTOMOBILE EMISSIONS PER 1000 GALLONS OF GASOLINE BURNED[a]

Pollutant	Amount, pounds
Carbon monoxide	3,200
Organic vapors	200 - 400
Oxides of nitrogen	25 - 75
Aldehydes	18
Sulfur compounds	17
Organic acids	2
Ammonia	2
Solids	0.3

[a]Reference 32.

As yet South Dakota does not have any metropolitan complexes which are of a size and character that would give rise to Los Angeles type "smog" conditions. However, it is well to remember that motor vehicles, in the absence of "smog" conditions, are still a source of considerable air pollution in the urban atmosphere.

INDUSTRIAL SOURCES

Agriculture

Ever since South Dakota entered the Union in 1889 agriculture has been the leading occupation; 1959 farm income amounted to 630 million dollars or 62 per cent of the State's total income. Over 77 per cent of this farm income was derived from livestock and livestock products, and the remainder chiefly from corn, wheat, oats, and hay.[35]

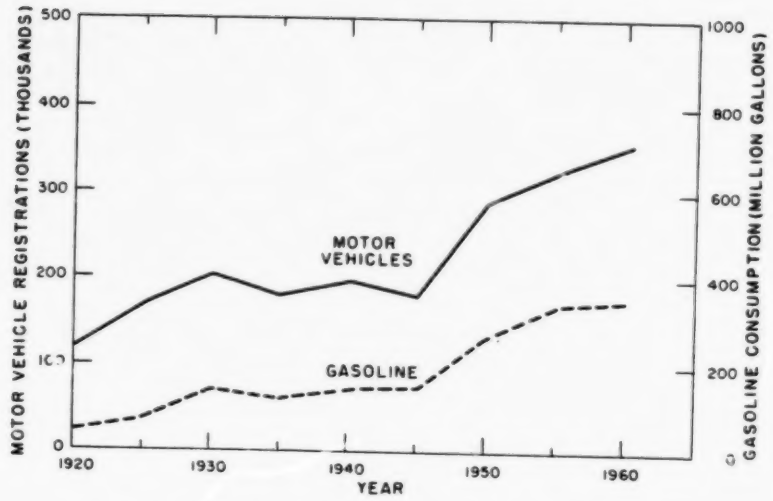

Figure 6. Motor vehicle registrations and gasoline consumption in South Dakota - 1920-1960 [26,34]

Agriculture in South Dakota is not significant as a source of air pollution except for dust storms that occur during periods of drought. Air pollution originating directly from farming operations, as opposed to the processing of farm products discussed under "Manufacturing," is limited to odors emanating from livestock feeding lots, odors and possible crop damage from drifting sprays of insecticides and herbicides, dust produced during cultivation, and smoke from field burnings.

Twelve officials noted on the questionnaires (Appendix B) complaints about odors emanating from livestock feeding lots; in most cases, these feeding lots were adjacent to residential areas.

Electric Power Generation

South Dakota has five electric power utility companies operating ten steam-electric generating plants. These plants, located in Rapid City (2), Lead, Pluma, Mobridge, Sioux Falls (2), Aberdeen, Mitchell, and Brookings, produced 519 million kilowatt hours of electricity in 1960.[36]

Steam-electric generating plants consume more fuel than any other single industry in the State (Table 9). These plants can be a source of atmospheric pollutants including fly ash and oxides of sulfur and nitrogen. The air pollution emitted by this industry can be measured in tons per day because of the large quantities of fuel involved. The yield of air pollution for a given amount of heat

produced depends upon the fuel burned, the chemical composition of the fuel, the type and condition of firing equipment, methods of operation, and the efficiency of air pollution control equipment.

Table 9. FUEL CONSUMED FOR POWER GENERATION SOUTH DAKOTA - 1960[a]

Fuel	Fuel consumed by the power industry	Power industry fuel consumption as percent of total state fuel (Approximate)
Coal	243,000 tons	27
Oil	12,000 barrels	less than 1
Gas	4,782,000 MCF[b]	19

[a]Reference 36.
[b]MCF = One thousand cubic feet.

Total pollution emitted from the combustion of gas is considerably less than that emitted from either coal or oil. The combustion of oil and coal is accompanied by large pollutant emissions that are related to the chemical composition of the fuel. For example, larger ash and sulfur proportions in the fuel result in a correspondingly larger yield of sulfur oxides and fly ash in the discharged materials.

Fifty-three per cent of the heat required to produce electricity in South Dakota in 1960 was supplied by gas and 46 per cent by coal. The popularity of gas and coal is attributable to the favorable cost per unit of heat supplied; in 1960 a coal or gas heat unit cost one half as much as an oil heat unit.[36]

Atomic energy will be used to produce electrical energy in South Dakota in the future. The Central Utilities Atomic Power Associates have under construction in Sioux Falls an experimental atomic power plant appropriately named "Pathfinder." This project is a joint venture of 11 Midwest electric companies and the Atomic Energy Commission. The Pathfinder power plant, to be completed in 1962, will consist of an atomic reactor known as a "Controlled Recirculation Boiling Water Reactor," with a capacity of 66,100 kilowatts.

The Pathfinder Reactor will discharge some air-borne radioactive materials; these will be controlled so as not to exceed acceptable safe limits for the discharge of radioactive materials.

Manufacturing

In the past, manufacturing has played a relatively minor role in the economy of South Dakota. The number of manufacturing

establishments has been increasing and prospects for further expansion are good in some areas of the State (See Economy). Although income and employment for manufacturing are still considerably less than for agriculture, (6.8 per cent employed in manufacturing as compared with 30.5 per cent for agriculture in 1960) manufacturing will become more important as a source of income.[37]

The trend toward increased manufacturing in the State is illustrated by the following information from the 1947 and 1954 Census of Manufacturers.[38, 39] From 1947 to 1954 the number of manufacturing establishments increased 11 per cent, the number of manufacturing employees increased 14 per cent, and the dollar value added to goods by manufacturing increased 52 per cent. The Southeastern Region (See Figure 5) of the State showed the largest gain in manufacturing employees and dollar value added to goods by manufacturing and the Black Hills Region posted the largest numerical increase in manufacturing establishments.

Air pollution from manufacturing operations can be divided into two classes: emissions resulting from heat and power production and emissions from industrial processes and operations, e.g. dust from rock crushing. Table 10 shows that manufacturers are important consumers of fuel. The pollutants emitted from use of fuel are similar qualitatively to those emitted by residential space heaters. Combustion efficiency, chemical composition of fuels, and the efficiency of air cleaning equipment determine the amount of pollution emitted per unit of fuel burned. Emissions from manufacturing processes are composed of a wide variety of gases and solids.

Thirty-two of the questionnaires (Appendices B and C) named manufacturing as a cause of air pollution problems in the community, particularly the following classifications.

Table 10. FUEL CONSUMED FOR MANUFACTURING - SOUTH DAKOTA - 1954[a]

Fuel	Amount consumed in manufacturing	Total fuel consumption in State	Manufacturing fuel consumption as percent of total state fuel consumption
Coal[b]	38,000 tons	838,000 tons[e]	5
Oil[c]	99,000 barrels	3,500,000 barrels	3
Gas[d]	3,254,000 MCF[d]	11,921,000 MCF[f]	27

[a]Reference 38.
[b]Includes bituminous and anthracite.
[c]Includes distillate and residual.
[d]Includes natural, manufactured, and mixed.
[e]This figure is for 1957 because 1954 data were not available.
[f]MCF equals one thousand cubic feet.

Illustration 9
Wastes from sugar beet processing are a source of objectionable odor.

Foods: Food processing is the largest of South Dakota's manufacturing industries and accounts for approximately two-thirds of the dollar value added to goods by manufacturing and two-thirds of the manufacturing employment and payroll.[40] The 1959 Manufacturer's Directory for South Dakota listed 718 establishments in this group.[41]

Of the 32 questionnaires mentioning manufacturing as a source of community air pollution, 24 named food processing establishments. Complaints included odors from milk and cheese processing plants and from slaughtering operations and accompanying livestock pens, dust and odor from alfalfa dehydration, and dust from the grinding of grains and the handling of grain at elevators.

Dusts and odors from food processing are usually annoying to surrounding residents. In many cases the problem appears small because these pollutants affect only a small area; however, the total number of citizens affected is considerable.

Minerals: South Dakota possesses a wide range of valuable mineral resources, many of which are presently being mined and processed. Gold is the most important mineral resource supplying approximately 45 per cent of the industry's total income; clay, sand, gravel, and stone provide most of the remaining 55 per cent.[12] This industry is becoming more important to the State's economy with increasing construction activities. Between 75 and 80 per cent of the total income from mineral production in South Dakota for 1955 came from five counties located in the Black Hills Region.[12]

Eight questionnaires cited two operations as sources of air pollution: the dust discharged in the production of cement and the crushing of rock. In addition to annoying residents, cement and rock dusts are responsible for damage to property and vegetation, according to questionnaire returns.

Lumber: The sylvan lands of South Dakota, located in the Black Hills, contain an estimated three billion board feet of Ponderosa pine. Most of this land is under the jurisdiction of the United States Forest Service, and the remainder is owned by South Dakota, Wyoming and by private interests.[12]

The lumber industry in this area began in 1875 when timbers were used to shore up the first gold mines. Today, over 20 sawmills are scattered throughout the Black Hills. Each of these mills produces at least 200,000 board feet annually. There are an additional 30 sawmills producing insufficient quantities to classify them as commercial producers.

Approximately half of a log entering a sawmill leaves as bark, sawdust, shavings, and coarse residue.[42] If facilities are available, useful by-products can be made from these wastes; otherwise, sawmill wastes create a disposal problem that is usually solved through incineration. Throughout the Black Hills the majority of sawmills use incineration to dispose of these combustible wastes.

The conventional incinerator for sawmill waste disposal is a teepee-shaped, single-walled, steel burner. A study of these burners by Oregon State College revealed that "...at some operations (they) have done a creditable job in consuming waste products with only a minimum discharge of smoke and cinders."[42] However, the

Illustration 10
The emissions from this tepee-shaped wood waste incinerator could be reduced with minor alterations and efficient operation.

problem occurs when improperly constructed burners are used or when properly designed and constructed teepee burners are not operated efficiently or when they are not properly maintained. Four questionnaires mentioned these burners as a source of pollution.

Chemicals: The chemical industry in South Dakota accounts for only a small portion of the State's industry. Two chemical processes, however, the production of grease and tallow in rendering plants and the production of ammonium phosphate fertilizers, have caused air pollution problems in a number of communities.

On three questionnaires, city officials noted odor nuisances from rendering plants in their communities. These plants process dead animals and slaughter house offal to retrieve grease and tallow used in soap manufacturing, tankage used as animal feed, and dried blood for fertilizer. Malodors arise from the cooking operation and the putrefaction of raw materials awaiting cooking.

Odors from the cooking process can be controlled by an afterburner or by the introduction of odorous gases into the firebox of a steam boiler.[43] A good system of housekeeping will aid in controlling odors associated with raw materials awaiting cooking.

Ammonium phosphate fertilizer plants were named on three questionnaires as sources of odor. On one questionnaire, the emissions from a fertilizer plant were alleged to have caused damage to adjacent trees.

Petroleum: At present the most noticeable source of air pollution in this category is the asphalt roadmix batching plant. These plants prepare a mixture of sand and gravel, which is dried and heated to a temperature between 250° and 450°F; then an asphaltic binder is added to formulate a paving material.[43]

Without control equipment these plants emit large quantities of dust. In addition, the combustion of oil or gas for heat results in emissions characteristic of the fuel used. The amount of air pollution emitted is related to the fuel used in the kiln, the percentage of fine aggregate in the mix, the binder, the air cleaning equipment, and efficiency of plant operation.

According to one official, asphalt paving operations have been the source of pollution responsible for limited vegetation damage on several occasions. On all occasions the damaged vegetation was on property abutting the right of way.

If the Williston Basin proves to be a petroleum and natural gas reserve, (See West North Central Region under the title "Economy") planning for the development of this area should include whatever measures may be necessary to preserve the area's air resources.

Illustration 11
Asphalt roadmix batching plants emit large quantities of smoke and dust. The portability of these plants frequently poses a jurisdictional problem.

NATURAL SOURCES

Dust and aeroallergens (pollen, danders, hair, fur, feathers) constitute the principal natural air pollutants in South Dakota. Surface dust becomes airborne by wind action and from man's activities such as construction, soil cultivation, and travel on dirt and gravel roads. Dust is most abundant and noticeable during dry periods, usually in late summer. It settles on cars and plants and permeates houses. Periodically, South Dakota experiences long droughts, which result in dust storms capable of causing extensive damage to crops and property.[44]

Hay fever sufferers attest to the presence of aeroallergens during the hay fever season. Statewide sampling has confirmed the presence in the atmosphere of elm and pine pollens in early spring, grass pollen in early summer, and ragweed, burning bush, and Russian thistle pollen in the late summer.[45] In addition a number of fungus spores were also collected.

Pollution from natural sources is extremely difficult if not impossible to control.

METEOROLOGY, CLIMATOLOGY, AND TOPOGRAPHY

Once pollutants are emitted to the atmosphere, air movements determine the direction the pollutants will travel and to what ex-

tent they will be diluted, and consequently, the concentrations present at any point. A knowledge of the air movements over South Dakota is essential, therefore, to an understanding of South Dakota's air resources. Since topography significantly influences the meteorological characteristics of an area, a brief discussion of the State's topography is included.

TOPOGRAPHY

The Missouri River, which drains the entire State with the exception of a small area in the northeastern corner, divides South Dakota approximately in half. It flows due south from the North Dakota boundary to Pierre and then in a southeasterly direction to the Nebraska line where it forms the boundary between the two States. The eastern half of the State is most accurately described as a prairie and, because of its nearly flat terrain and annual rainfall, is well-suited to farming. In contrast, the western half of the State is more rugged and consists of canyons, broad upland flats, and buttes. Rainfall here is insufficient for farming, but is adequate to support grasslands for cattle grazing.

South Dakota's terrain slops generally from 1100 feet above sea level in the southeastern corner to 2900 feet above sea level in the northwestern corner. The highest point in the State is Harvey Peak, 7242 feet above sea level, and the lowest point is Big Stone Lake, 962 feet above sea level. The outstanding exception to this generally sloping terrain is the Black Hills on the western edge of the State. The Black Hills are a group of forest-covered mountains with a different climate than the remainder of the State. [46]

WINDS

South Dakota's relatively level terrain and a notable lack of trees and ground obstructions result in stronger winds favorable to the dispersion of atmospheric pollutants. Winds throughout the State are stronger than in most States, averaging between 11 and 12 miles per hour; the strong winds occur during daylight hours and most of the light winds at night. [46]

During the winter, winds are predominantly from the northwest while in summer, southeasterly winds prevail. [15, 17, 46] A notable exception is Rapid City, at the base of the Black Hills, where northwesterly winds prevail throughout the year. [16] Although the prevailing winds are from the northwest and southeast, winds from all directions are observed throughout the year. (Figure 7)

The frequency of winds of less than 1 mile per hour (calm) is significant in air pollution evaluations; these winds lack sufficient velocity to effect the dispersion of air pollutants, and high concentrations may result. Hourly wind observations indicate that most South Dakota cities experience few calm periods, the percentages were Aberdeen (1.3), Sioux Falls (3.2), Watertown (4.6), and Rapid

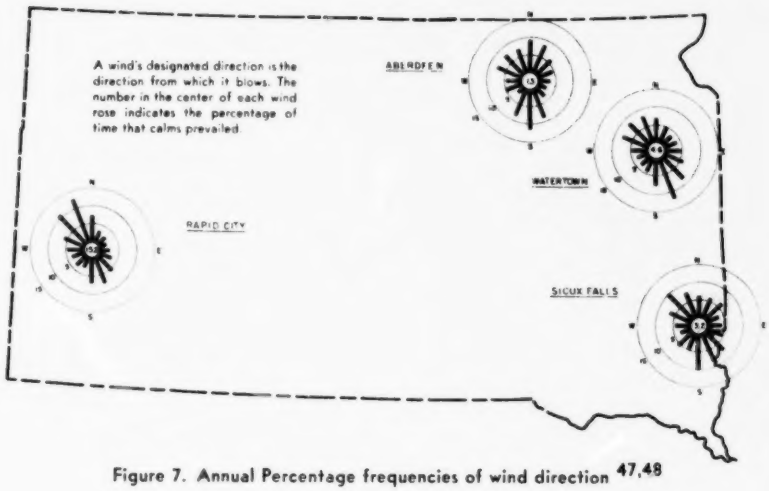
A wind's designated direction is the direction from which it blows. The number in the center of each wind rose indicates the percentage of time that calms prevailed.
ABERDEEN
WATERTOWN
RAPID CITY
SIOUX FALLS

Figure 7. Annual Percentage frequencies of wind direction [47,48]

City (15.2). Calm periods are recorded more frequently in the fall and less frequently in the spring.

ATMOSPHERIC STABILITY

In addition to the dilution afforded by horizontal winds, atmospheric pollutants are diluted by vertical air movements. Pollutants are concentrated in the absence of horizontal winds and vertical air movements. The beneficial or detrimental effect of vertical air movements is dependent on the change in air temperature with elevation above the ground.

Unstable atmospheric conditions, or those conducive to pollutant dispersion, occur when the air temperature decreases with increasing elevation. Under these circumstances, the warmer and lighter air near the earth's surface rises carrying pollutants aloft and in this manner effecting dilution. Conversely, if the air temperature increases with increasing elevation (inversion) the atmosphere is said to be stable. Under stable conditions, the air near the earth's surface is cooler and heavier than the upper air and therefore will not rise. This lack of vertical circulation, accompanied by light surface winds, allows pollutants to accumulate. In most areas, maximum concentrations of air pollution are recorded during inversion conditions.

Plumes from elevated stacks, which under ordinary meteorological conditions pose no problem, can, under inversion break-up conditions, cause damage and nuisance. At night these elevated plumes sometimes drift for long distances in a narrow fan or ribbon-like stream. Then when the sun's heat reaches the earth's surface the following day, rapid mixing brings the pol-

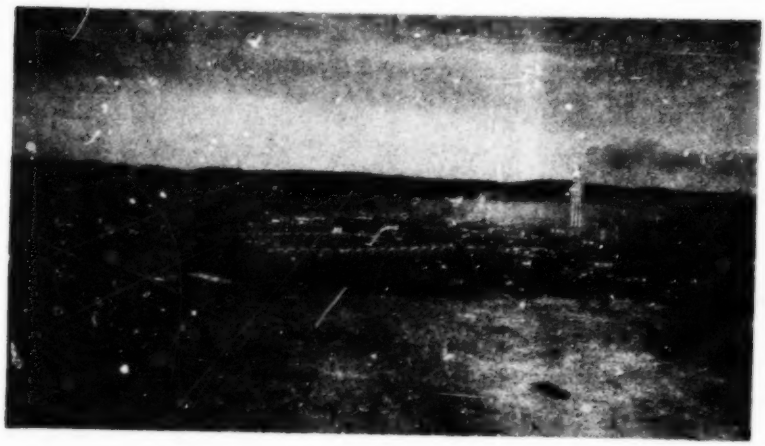

Illustration 12
Air pollution concentrates during periods of poor atmospheric dispersion.

lutants to the ground in high concentrations for short periods of time. This phenomena is known as a "fumigation".

In South Dakota inversions are linked closely to the diurnal cycle, which generally consists of daytime instability (good dilution) and nocturnal stability (poor dilution). The strongest inversions usually occur on cold nights under clear skies. Pollutants emitted into the atmosphere from sundown to sunrise during these inversions tend to accumulate. South Dakota meteorological data show inversions exist on an hourly basis 40 to 50 per cent of the time in the winter and approximately 30 per cent of the time in the summer.[49]

According to Korshover, past major air pollution episodes have usually been associated with prolonged (4 or more days) inversion conditions accompanied by light winds (atmospheric stagnations). Korshover studied the frequency with which these stagnations occurred East of the Rocky Mountains between 1936 and 1956.[50] He reports such 4-day stagnations did not occur in South Dakota during that period. This indicates that prolonged inversions resulting in pollution buildups of episode proportions are improbable in South Dakota.

FOG AND THUNDERSTORMS

Fog and thunderstorms are important in air pollution because they indicate certain atmospheric conditions which favor or restrict dispersion of pollutants. Thunderstorms and heavy showers are associated with unstable conditions conducive to pollution dispersion; fog is associated with stable conditions and light winds, which

favor the accumulation of atmospheric pollutants.

Annual precipitation in South Dakota varies from 21 inches in the southeast to 13 inches in the northwest with the exception of one area in the Black Hills that receives about 25 inches. Most of the precipitation falls during the growing season, between April and September. Thunderstorms are prominent in summer with an average of one thunderstorm every third day during June, July, and August.[15, 16, 17]

In addition to indicating stable atmospheric conditions, fog delays the return of unstable conditions by reducing the amount of solar radiation reaching the earth's surface. Heavy fogs are not frequent in South Dakota compared with other areas of the country and do not significantly affect the dispersion of pollutants.

Summarizing, South Dakota experiences fewer periods of poor dispersion than most states. Level terrain and general lack of obstructions result in winds favorable to the dispersion of pollution with stronger winds during the day and most calms at night. The prevailing winds are from the southeast in the summer and the northwest in the winter, although winds from all directions are well represented in all months. Inversions are generally linked to the diurnal cycle with daylight instability (good dispersion) and nocturnal stability (poor dispersion). Pollutants emitted during a strong nighttime inversion (usually clear, cold nights) may result in large concentrations in the immediate area. Pollution from elevated stacks, under inversion breakup conditions, may cause damage or nuisance in areas miles away. Each day usually will have some period when atmospheric conditions are favorable for pollution dispersion which means industries whose emissions can be stored or otherwise delayed can release pollution during favorable conditions. The occurrence of a 4-day atmospheric stagnation in South Dakota is unlikely.

PRESENT AIR POLLUTION PROGRAM IN SOUTH DAKOTA

STATE GOVERNMENT

Legislation

To date the State Legislature has not enacted legislation specifically for the control of air pollution. A number of general laws dealing with nuisance abatement and the protection of the public health have been enacted.[51] These general laws are not specifically directed toward control of air pollution, but at present they are the only available legal basis for attacking the State's

air pollution problems. These laws enable:

a) Townships and municipalities to determine what constitutes a nuisance and to abate the same.

b) Townships and municipalities to take action required for the protection of the public health.

c) The Public Health Advisory Council to promulgate rules and regulations for the protection of the public health.

d) County Boards of Health to enforce rules and regulations adopted by the State Department of Health.

There are four reasons why this legislation, which lacks specificity to deal with present or potential air pollution problems in the State, is not considered adequate.

First, existing legislation authorizes the control of air pollution only when it endangers the public health or constitutes a nuisance. Air pollution has several additional effects. Legislation is needed that will recognize and permit control of the several manifestations of air pollution.

Second, control activities under existing legislation are limited to the abatement of nuisances. Townships and municipalities may adopt ordinances declaring certain acts or situations to be a nuisance and any person violating the ordinance may be ordered to abate the nuisance or pay a fine. Although this law grants some authority to adopt ordinances for the control of air pollution it would be helpful to have a State law which grants municipalities, townships, and counties specific authority to adopt ordinances regulating air pollution.

Third, existing legislation fails to provide a mechanism for controlling air pollution that may be transported from one political jurisdiction to another. Interjurisdictional pollution problems can involve two or more cities, a city and the surrounding county, two or more counties, and sometimes adjacent states. In a number of municipalities in South Dakota a pollution source outside the city limits and beyond municipal jurisdiction is responsible for air pollution within the municipal jurisdiction. Legislation should make it possible for the State to assist in resolving such interjurisdictional disputes.

Fourth, under existing statutes townships and municipalities are unable to regulate the establishment of potential sources of air pollution. Clear-cut authority is needed to permit counties, townships, and municipalities to require that suitable provisions be made in proposed establishments to control air pollution emissions. This is normally accomplished by a review and approval of construction plans by a government agency prior to installation of the new facility. This type of preventive program is preferable to

programs which wait until problems arise before control action is taken.

In summary, an analysis of existing State statutes indicates that legislation is neither adequate nor effective in dealing with air pollution in its entirety.

Program Activities

Inasmuch as existing legislation does not assign definite responsibility for air pollution control to any State agency or board, no significant air pollution control activities are presently being conducted on the State level.

LOCAL GOVERNMENT

Legislation

Under the authority delegated by the State Legislature as outlined in the previous section, some municipalities have adopted ordinances defining nuisances. As a general rule, the ordinances of larger municipalities are somewhat more specific and comprehensive than those of smaller municipalities.

The ordinances usually include clauses prohibiting:

1) the burning of garbage

2) bonfires in public places (excludes back-yard burners)

3) the location of a slaughter house or rendering plant within one mile of the city limits

4) the emissions of sparks, cinders, coal, ashes, smoke or fumes from smokestacks in sufficient quantities to endanger the health, comfort or property of others.

These local ordinances are not adequate to cope with all of the problems associated with the control of air pollution; they are neither comprehensive enough to combat pressing problems nor flexible enough to adapt to changing situations.

In addition to ordinances dealing with nuisances, some municipalities have adopted ordinances that prohibit open burning during dry periods designated by the fire chief. This precautionary measure is, of course, aimed at property protection through fire prevention.

At least one municipality surveyed had adopted a zoning ordinance (planned land use) and another municipality was in the process of adopting a similar ordinance. The zoning ordinance in effect controls the location of industrial and residential areas within the municipality. Properly drafted zoning and open burning ordinances can be very useful in a comprehensive air pollution control program.

Program Activities

At present no county, township, or municipality employs personnel solely for the purpose of air pollution control. On a municipal level control activities are limited to an occasional complaint investigation, incidental benefits derived from other municipal functions, and the operation of two National Air Sampling Network stations in cooperation with the U. S. Public Health Service. The Sioux Falls Health Department cooperates with the State Department of Health by operating an urban air sampling station for the National Air Sampling Network; a nonurban sampling station in the Black Hills is operated in cooperation with the U. S. Forest Service. These are two of over 200 similar stations located in communities throughout the country which collect basic data on the nation's air resources.

Suspended particulate matter is an indicator of air pollution measured at the Sioux Falls (urban) and the Black Hills (nonurban) sampling stations. Measurements indicate that the average pollution level in Sioux Falls is comparable to cities of similar size participating in the network and the average pollution level at the Black Hills station is about one-half of the national nonurban average. Average pollution levels in Sioux Falls are six times the average Black Hill's level.[52]

Existing legislation discussed above is inadequate to cope with all aspects of air pollution on the local level; however, it does permit abatement of some air pollution problems in the nuisance category.

The effective use of the nuisance law to control certain air pollution problems is illustrated by the court case of Greer versus the City of Lennox, a Municipal Corporation of the State of South Dakota. (107 N. W. 2d 337, February 2, 1961, Supreme Court of South Dakota).

In this case the owner of a farm adjacent to a public dump asked for damages on the grounds that the dump constituted a nuisance. The Circuit Court awarded the plaintiff $5000. The Municipal Corporation appealed to the Supreme Court, which held that the public dump, causing offensive odors and rat and fly infestation of the plaintiff's farm, did constitute a nuisance, entitling the plaintiff to damages.

Field observations during this survey revealed several other problems in the nuisance category which had not received adequate attention. This may have been due to public apathy in regard to these problems as well as legislative and control program deficiencies.

In summary, the prevalence of air pollution problems dis-

cussed elsewhere in this report stand in evidence of the need to improve control capabilities. Legislative changes are needed to clarify the position of State government and enable local government to conduct effective air pollution control programs.

APPENDIX A

A SUGGESTED BILL
FOR AN ACT ENTITLED, An Act relative to the control of atmospheric pollution.
BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF SOUTH DAKOTA:

Section 1. Whereas, the pollution of air can become a hazard to the safety, welfare, peace, and morals of the people of this state and can cause injury to the health and general welfare of the people of the state, it is hereby declared public policy of this State to control air pollution to the end that the least possible injuries shall be done to human, plant, and animal life and property.

Section 2. For the purposes of this Act, the following words and phrases are defined:

(1) Air pollution shall mean the discharge into the outdoor atmosphere of substances in quantities which are injurious to human, plant, or animal life or to property or unreasonably interfere with the comfortable enjoyment of life and property throughout the State excluding all aspects of employer-employee relationships as to health and safety hazards.

(2) Air pollutants shall include, but not be limited to, smoke, particulate matter, soot cinders, ashes, radioactive or toxic substances, fumes, vapors, gases, industrial odors, and dusts.

(3) Agency shall mean the South Dakota State Department of Health.

(4) Director shall mean the State Health Officer.

Section 3. The authority for enforcement of the provisions of this Act shall be vested in the State Department of Health, hereinafter referred to as the Agency.

The State Health Officer, hereinafter referred to as the Director, shall perform and carry out all functions, and duties given to the Agency under this Act, and shall direct, carry out, and enforce all air pollution control activities and measures vested in the Agency.

In accordance with the laws of the State, the Agency may employ, compensate, and prescribe the powers and duties of such persons as may be necessary to carry out the provisions of this Act.

The Director may delegate to officers and employees of the Agency, such functions, duties, and authority as are vested in the Agency by this Act; except the authority to adopt and promulgate standards, rules, and regulations, and to issue or modify orders.

Section 4. The Agency shall have the following powers and duties:

(1) Shall develop comprehensive policies and programs for the evaluation, prevention, and control of all sources of pollution of air in the State.

(2) Shall advise, consult, and cooperate with other agencies of the State, the Federal Government, other States and interstate agencies, and with affected groups, political subdivisions, and industries in the furtherance of the purposes of this Act:

(3) May accept and administer loans, grants, or gifts from the Federal Government and from other sources, public or private, for carrying out any of its functions;

(4) May encourage, participate in, or conduct studies, investigations, training, research, and demonstrations relating to air pollution, the measurement and control of air pollution, the effects on health of exposure to air pollution, and related problems as it may deem necessary or advisable for the discharge of its duties under this Act;

(5) Shall collect and disseminate information relative to air pollution, its prevention and control;

(6) Shall adopt, promulgate, and enforce such rules and regulations as may be necessary to implement or effectuate the powers and duties of the Agency under this Act;

(7) May issue, modify, or revoke orders prohibiting the discharge into the air of pollutant materials in accordance with the provisions of this Act and the rules and regulations adopted thereunder;

(8) May require any person to submit plans for the control of air contaminants;

(9) Shall encourage voluntary cooperation by the people, municipalities, counties, industries and others in restoring and preserving the purity of air within the State;

(10) May enter into contracts necessary to carry out the purposes set out in this Act;

(11) May make inspections of air pollution sources, controls

and immediate surroundings for the evaluation of air pollution problems;

(12) Shall represent the State of South Dakota in any and all matters pertaining to plans, procedures or negotiations for interstate compacts in relation to the control of air pollution;

(13) May exercise all incidental powers necessary to carry out the purposes of this Act.

Section 5. It shall be unlawful to discharge air pollutants into the outdoor atmosphere in amounts which are injurious to human, plant or animal life or to property or unreasonably interfere with the comfortable enjoyment of life and property.

Section 6. Designated representatives of the Agency shall inspect and examine such sources of air pollution as it desires, in order to determine compliance with the air pollution control regulations of the Agency.

Section 7. The Agency or its duly authorized representative shall have the power to enter at reasonable times upon any private and public property for the purpose of inspecting and investigating conditions relative to the purposes of this Act.

Any authorized representative of the Agency may examine any records or memoranda pertaining to the air pollution emitter and air pollution controls. The Agency may require the maintenance of records relating the air pollution emitter and air pollution controls. Copies of such records must be submitted to the Agency on request.

Section 8. Any person who violates any of the provisions of, or who fails to perform any duty imposed by this Act, or who violates any order or rule of the Agency promulgated pursuant to this Act, shall be guilty of misdemeanor, and in addition thereto may be enjoined from continuing such violation. Each day upon which such violation occurs shall constitute a separate violation.

It shall be the duty of the Attorney General on the request of the Agency to bring any action for an injunction against any person violating the provisions of this Act, or violating any order of the Agency.

Section 9. This Act shall not be construed as repealing any laws of the State relating to air pollution sources, exposures, and controls, but shall be held and construed as auxiliary and supplementary thereto, except to the extent that the same are in direct conflict herewith.

Section 10. If any section, subsection, sentence, clause, phrase, or word of this Act is for any reason held to be unconstitutional, such decree shall not affect the validity of any remaining portion of this Act.

APPENDIX B

Form No. 11.01

SOUTH DAKOTA STATE DEPARTMENT OF HEALTH
DIVISION OF SANITARY ENGINEERING
AIR POLLUTION APPRAISAL QUESTIONNAIRE

	YES	NO
1. Are there any operations (municipal, domestic, industrial) in your area of jurisdiction that emit objectionable amounts of smoke, fumes, dust or odor to the atmosphere?	( )	( )
2. In your opinion, are these pollutants present in sufficient concentration to cause:		
a. Discomfort or inconvenience to residents?	( )	( )
b. Damage to property? (autos, paint, clothing, buildings, etc.)	( )	( )
c. Damage to vegetation?	( )	( )
d. Injury to animal life?	( )	( )
3. Has your office received complaints concerning air pollution during the past two years?	( )	( )
a. If so, how many?_____	( )	( )
4. Are the air pollution problems in your area of jurisdiction due to: (Check as many as appropriate.)		
a. Municipal activities? (city dumps, incinerators, etc.) Number of complaints_____	( )	( )
b. Domestic activities? (incinerators, home heating plants, etc.) Number of complaints_____	( )	( )
c. Commercial activities? (service industries, hotels, laundries) Number of complaints_____	( )	( )

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d. Industrial activities? Number of complaints_____	( )	( )
e. Agricultural practices? Number of complaints_____	( )	( )
f. Natural sources?	( )	( )
5. Please describe briefly any air pollution problems in your jurisdiction. (Use reverse side.)		
6. In your opinion, is the problem described above of major ( ) or minor ( ) significance?	( )	( )
7. Are there any local ordinances including nuisance regulations and zoning provisions for the control of smoke, fumes, dust or odor? If available, would you please enclose a copy of any such ordinance?	( )	( )
a. Nuisance regulations?	( )	( )
b. Smoke, fume, dust or odor regulations?	( )	( )
c. Provisions in zoning laws?	( )	( )
8. Does any governmental organization in your area of jurisdiction take action to control sources of air pollution? If yes - please describe briefly on reverse side of sheet and, if you can, estimate the amount of time and money spent on this activity.	( )	( )
9. Are there sources of air pollution outside of your area of jurisdiction which have created a problem in your area?	( )	( )
10. Please list any groups (official or unofficial) in your area of jurisdiction who might furnish additional information regarding air pollution problems.		

Data obtained from this questionnaire will be compiled in the summary report. Your thoughtful and prompt completion will be appreciated.

Signed:_____ City:_____

Title:_____ County:_____

Date:_____

Please return to: G. J. Van Heuvelen, M. D., State Health Officer

APPENDIX C

Form No. 11.02

SOUTH DAKOTA STATE DEPARTMENT OF HEALTH
DIVISION OF SANITARY ENGINEERING
COUNTY AGENT'S AGRICULTURAL QUESTIONNAIRE

	YES	NO
1. Are there any operations (municipal, domestic, industrial, agricultural) in your area of jurisdiction that emit objectionable amounts of smoke, fumes, dust or odor to the atmosphere?	( )	( )
2. In your opinion, are these pollutants present in sufficient concentration to cause damage or injury to:		
a. Vegetation?	( )	( )
b. Animal life:	( )	( )
3. Has your office received complaints concerning air pollution damage to plant or animal life during the past two years?	( )	( )
4. Please describe briefly any air pollution problems in your jurisdiction. Give sources, type of damage and severity of the problem.		

_____

_____

5. Have any steps been taken in your area of jurisdiction to control sources of air pollution? Describe.	( )	( )

_____

_____

Signed: _____

County: _____

APPENDIX D

GUIDING PRINCIPLES

STATE AIR POLLUTION LEGISLATION

This compilation of guiding principles was prepared at the request of the Association of State and Territorial Health Officers by the Public Health Service in cooperation with the Council of State Governments.

It is now recognized that air, like water, is a limited resource. The discharge of waste products into the atmosphere can have harmful effects on health, comfort, and property. Air pollution control starts with the premise that no one has the right to use the atmosphere as a receptor of wastes in a manner which will adversely affect the health, comfort or property of others. The social and technical aspects of air pollution control activities must be considered in the application of controls and serve as justification for appropriate modification as necessary.

Since the end of World War II the increasing interest in the conservation of our country's air resource has been reflected to some extent by State legislation. Within the last decade more than 20 States have modified or adopted new legislation on air pollution; legislative activity at the local level has also increased during this period. At the national level the Congress enacted Public Law 159 in 1955 which provides for the Public Health Service program of research and technical assistance.

It is generally accepted that responsibility for administration of a program for the prevention and abatement of air pollution should be at that level of government capable of dealing with the problem in its entirety. While this may indicate the desirability of air pollution control programs at a local or regional level, due consideration should also be given to the role of the State.

A review of the provisions of existing State air pollution legislation suggests that certain principles can be formulated which may

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serve as a guide in the development of such legislation. While the suggested guiding principles are concerned with State-level legislation they are also applicable, with suitable modification, to local and regional legislation. These principles may assist State, regional, and local authorities who wish to make an appraisal of their basic statutes and ordinances on air pollution and evaluate them in terms of the actual air pollution problems that exist and the status of technical knowledge.

The goal of air pollution legislation should be to maintain a reasonable degree of purity of our air resources consistent with: (a) the public health and welfare; (b) the protection of plant and animal life; (c) the protection of physical property and other resources; (d) the visibility requirements for safe air and ground transportation; and (e) the continued economic development and growth.

In programs at all levels of government, control can be most effectively brought about only by legislation which is reasonable and based on technically-substantiated criteria. It should provide adequate flexibility, yet be reasonably specific to meet the needs of the area under consideration.

State air pollution control activity has developed traditionally out of the authority of health departments to preserve public health. On the local level, however, air pollution control authority has been vested in a variety of agencies, including health, building, fire, public safety, and other departments.

Early State statutes frequently provided an administrative approach which was largely negative in character. That is, when a particular activity was found to cause air pollution the administrative agency was authorized to take steps to abate such pollution. The modern approach shows a shift in emphasis from the abatement of existing air pollution to a more positive means of control through prevention.

More recently-enacted State statutes usually embody one or more of three general approaches, as follows:

1. A broad enabling act permitting the establishment of air pollution control districts at local option.
2. A research and technical assistance program.
3. An air pollution control program concerned with the prevention and abatement of air pollution problems in all areas of the State.

Guiding Principles

General

While it is not intended to make a section-by-section analysis

of the State statutes currently in effect, the following is intended to provide a convenient check list of considerations involved, based on a study of those statutes. Further experience may indicate that these guiding principles should be revised in the light of legal, technical and administrative developments.

A. Definitions

A definition section is an integral part of a comprehensive air pollution control statute. This section is important to the administration and interpretation of the statute and unduly restrictive or vague definitions should be avoided. The definition of the term "air pollution" is the most important one in a statute and should be broad enough so that control efforts will protect all the air resources of the State. "Air pollution" may be defined as "the presence in the outdoor atmosphere of one or more air contaminants or combinations thereof in such quantities and of such duration which are or may tend to be injurious to human, plant, or animal life, or property, or which unreasonably interfere with the comfortable enjoyment of life or property, or the conduct of business." This language makes it unnecessary to show that life or property already have been injured or that their comfortable enjoyment already unreasonably disturbed, so long as the pollution situation is generally known to effect those results. The definition encompasses the preventive and abatement aspects. Similarly, the definition of "person" should not be restrictive but should include the State, any municipality, county, public or private corporation, partnerships, firm or other entity or individual.

B. Administrative Agency

In legislation which would authorize a state-wide air pollution control program, it is essential that there be a specific designation of an agency responsible for the administration of the program. The problems of air pollution control concern interests other than health. Consequently, the agency established or designated to administer the program shall be so constituted as to take into account the interests and views of all affected groups, in addition to public health considerations.

Some States which have recently enacted air pollution control legislation have entrusted its administration to a board or authority, in the State health department, representative of the interests considered to be affected. Such boards are sometimes made up of representatives of various departments of the State government, sometimes of citizens from outside the government, and more frequently a combination of the two. The adoption of this procedure has the advantage of facilitating representation of affected interests in the agency. These bodies, among other things, may promulgate codes, rules and regulations, which are enforced by the State health department or by the body itself.

Some States may wish to vest responsibility for the program in a single administrator, such as the State health officer. If this is done, it would seem advisable to secure representation of affected interests through an advisory council, and it may also be considered desirable to set up a board of review to hear appeals from the administrator's decision.

Where a State air pollution control agency is to be established in an existing department, it is obviously desirable that it be placed in a department having competency in terms of experience, personnel and facilities.

C. Administrative Powers

Many of the acts confer on the air pollution control agency concerned in the requisite administrative powers to carry out its responsibilities. Thus, the agency is empowered to hold hearings, subpoena witnesses, enforce its subpoenas, administer oaths, examine plans and specifications, require the keeping of records and making of reports, and enter on property at reasonable times for purposes of inspection and investigation.

D. Air Classification - Air Quality Standards

Some State agencies in the administration of their air pollution control programs are authorized by their legislation to divide the State into areas according to prevailing land-use with standards of air quality for the designated areas being set in accordance with such use. Classification of areas and establishment of standards are considered by some authorities to be essential elements of any comprehensive program of this type.

The classification of areas and the promulgation of emission limitations have a definite legal effect and their violation is made unlawful; conversely, discharges which comply with such classification standards are not pollution within the meaning of the statute. In view of the number of persons affected by classifications and standards, the statutes usually require that their adoption be preceded by a public hearing open to all residents of the areas affected, and that adequate notice be given. Such statutes also provide that in the classification of areas, and the establishment of standards, the administrative agency would be guided by the principle of constantly seeking to improve the air quality to the maximum extent practicable.

Many of the State air pollution statutes, other than the technical assistance and research type, give the responsible agency the power to promulgate implementing rules and regulations for the prevention and abatement of air pollution. In this connection, the enforcement powers are not usually held in abeyance until such action can be completed.

To re-emphasize at this point the necessity of developing stan-

dards, codes, rules and regulations governing the emission of air pollutants on the basis of technically accepted criteria, consideration should be given to local conditions, such as topography, meteorology, industrial development, degree of urbanization, and land-use planning. Their content relating to permissible levels of air contaminants should be approached with due consideration to the desires of the area and the economics involved, especially where health effects are not clearly indicated.

E. Permits

Potentially, one of the most effective techniques for control of air pollution is a permit system under which discharges of pollutants into the air are limited by the agency after examination of plans, specifications, and other data for equipment which can meet the prescribed standard. Through this means the agency can condition its approval on the provision of controls adequate to protect the air resources of the State and to meet the requirements on the emission of pollutants. There is, on the other hand, a group of authorities who prefer a procedure which requires registration of all sources of regular or anticipated emission above some minimum size. The possible use of permit and registration systems, might in certain cases, prove desirable.

F. Enforcement

Statutes now in effect provide a variety of methods for proceeding against any alleged pollutor. It is made unlawful to cause any pollution of the air in the area of jurisdiction in terms of the definition of air pollution, or to violate any order issued by the agency, including an order classifying areas of the jurisdiction or establishing limitations on emission of air pollutants. In some cases air pollution is declared to be a public nuisance and is therefore subject to abatement in accordance with the practice for abatement of nuisances.

In this connection the concept is being more generally accepted that the police power of the State and properly authorized local government extends to the regulation of air pollution without regard to whether the condition constitutes a common law or statutory nuisance. The validity of a statute or ordinance regulating the emission of pollutants does not depend upon whether or not it is in fact a nuisance. Nor does it add to the validity of the legislation to declare that such emission constitutes a public nuisance.

The criteria used to judge the validity of a statute regulating conduct which does not constitute a common law nuisance are those applied to determine the proper exercise of the police power - namely, that the statute is reasonably necessary for the accomplishment of the purpose and for the public welfare, is not unduly oppressive, does not arbitrarily interfere with private property or impose unnecessary restrictions upon its use.

The violation of the provisions of such statutes, or order, a determination by the agency of failure to perform any duty imposed by the statute is declared to be a misdemeanor. The principal method of making an air pollution control program effective through the compulsory process, however, is by administrative action. The control agency is empowered to issue orders against alleged pollutors after adequate opportunity for hearing. Such orders, if not appealed through the courts, become final and are enforceable in much the same way as a judgment of a court. The same administrative procedure, a hearing, is employed in the case of revocation, denial, or modification of permits.

Many of the statutes provide that appeals may be taken to the courts from orders of the control agency. Such appeals do not generally involve trial de novo but are primarily reviews of the legal propriety of the agency's decision. If the prescribed statutory procedure has been followed and the determination is supported by substantial evidence, the order of the agency will usually be affirmed by the court. On the other hand, in a trial de novo the Court is authorized to exercise its independent judgment on the evidence and to make an independent determination of the reasonableness and legality of action on all issues of law, facts, and mixed questions of law and facts and opinions therein involved.

It should be noted that there is growing support for the view that the test for air pollution as it relates to health should not be limited to conditions which actually or inevitably result in disease or damage but should include those conditions which create a hazard, danger, or peril to the public health.

G. Severability

A severability clause is usually included to provide that if any part of the statute is declared unconstitutional, the other parts shall continue in force and effect.

Specific

A. State Air Pollution Control Legislation

Limited operational experience indicates that such legislation may:

(a) Provide the basis for establishing the organization of the air pollution control agency and for the recruitment of personnel.

(b) Authorize the utilization of personnel and facilities of other State agencies and reimbursement therefor.

(c) Provide the basis on which the agency can plan a comprehensive program taking into account the varying conditions of different areas of the State.

(d) Provide the agency with the authority for the promulgation of rules and regulations based upon needs as determined on the basis of appropriate surveys and hearings before such promulgation.

(e) Provide for the solution of local or regional air pollution problems by authorizing the formation of local and regional air pollution control organizations.

(f) Provide that nothing in the legislation should impair or abridge the power of any local or regional air pollution contol agency to promulgate rules and regulations whether they be the same or more stringent than those promulgated by the State agency.

(g) Authorize the State agency to take action in the absence of, or failure of, a local or regional control agency having jurisdiction to control air pollution, and to resolve interjurisdictional disputes.

(h) Authorize the agency to establish appeal or hearing procedures for cases resulting from direct action of the agency.

(i) Authorize the agency to conduct a research program on air pollution and conduct field studies and investigations related to air pollution as it may deem necessary.

(j) Authorize the agency to collect and disseminate information relating to air pollution and its prevention and control.

(k) Authorize the agency to provide technical assistance and cooperation to local control programs, industry, and other affected groups.

(l) Authorize the agency to receive or initiate complaints and to take the necessary action, after a public hearing, for the abatement of air pollution and establish a penalty for failure to comply with orders of the agency.

(m) Make clear that all cause and effects of air pollution are included within the area of responsibility of the State Agency. In addition to health effects, these would include the effects on plant and animal life, on structural material and surfaces, and on visibility particularly as it affects air and surface transportation.

(n) Authorize the agency to cooperate with appropriate agencies of the United States or other States or any interstate agency or international agency with respect to the control of air pollution.

(o) Authorize the agency to serve as the agency of the State for the acceptance and financial administration of monies from the Federal government or other public or private agencies.

B. "Local Option Legislation"

The effectiveness of local option type legislation is enhanced when the State agency is authorized to take the necessary steps to resolve inter-jurisdictional air pollution problems. In addition, authority should be granted to the State to deal with those problems beyond the jurisdictional limits of a community. Another technique which merits consideration is the authorization by the States for their political subdivisions to enter into interlocal agreements or contracts. This authorization would leave it up to the local governmental units to decide what function or functions might better be performed by them in concert. It is to be noted that the procedure of interlocal agreement may be considered for use between or among communities whether or not they are located within a single State.

Legislation of this type may:

(a) Provide the procedure by which, and conditions under which, a district may be activated and organized involving one or more cities or counties and the formation of metropolitan authorities.

(b) Provide for the names and the general and specific powers of the district.

(c) Provide for an air pollution control board and hearing board for each district and the duties of such boards.

(d) Provide for the appointment, powers and duties of officers and employees of the district.

(e) Authorize appropriations to the districts by counties and cities comprising such district.

(f) Provide for standards for the control or prohibition of obvious pollution and prohibiting pollution which may be either actually or potentially harmful to persons or property. During an emergency, such as may develop under adverse meteorological conditions, short-time curtailment of community and industrial activities which contribute to pollution may be necessary. Although such an emergency condition is seldom encountered, it is essential that duly-constituted governmental authority anticipate such a problem, and be prepared to act through a prearranged procedure.

(g) Provide for injunctive relief against certain violations,

and for criminal and civil penalties.

(h) Provide for appeals to appropriate courts on the basis of existing statutes.

C. Research and Technical Assistance Legislation

Legislation of this type usually provides the following:

(a) Authority for the conduct of studies to determine the effects of air pollution upon human, animal and plant life, and upon materials and related matters.

(b) Authority to maintain a laboratory to provide services necessary for the abatement and control of air pollution.

(c) Authority to conduct such research as may be necessary.

(d) Authority to determine by means of study those factors responsible for air pollution.

(e) Authority to develop and maintain a system of monitoring the atmosphere for purposes of determining the presence and quantity of air pollutants.

(f) Authority to assist local and regional agencies by means of cooperative activities and consultation.

(g) Authority to collect and disseminate information relating to air pollution and for the prevention, control, and abatement thereof.

(h) Authority to accept and administer grants from the Federal government and other sources, public or private, for carrying out any of the functions indicated above.

Education

While appropriate legislation is essential, proper emphasis should be placed upon education and securing the voluntary cooperation of all persons and organizations who may contribute to air pollution or who are interested in its control. Encouragement should be given to associations of municipalities, industries, or other groups who severally or jointly may be of help in planning its effective control.

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